

CLAIMS

What is claimed is:

- 1 1. A method comprising:
2 dynamically discovering an available lightpath route comprising a concatenation of a
3 plurality of lightpath segments connected via respective nodes along a route spanning from a
4 source edge node to a destination edge node and including at least one switching node in an
5 optical switched network;
6 generating a lightpath reservation message containing an explicit route corresponding
7 to the available lightpath route that was discovered and a scheduled time slot during which
8 network resources are to be reserved; and
9 reserving resources along the explicit route to enable transmission of data between the
10 source and destination nodes along the explicit route during the scheduled time slot, wherein
11 reservation of the resources causes said at least one switching node and the source and
12 destination edge nodes to be configured so as to form a virtual optical-switched circuit
13 between the source and destination edge nodes during the scheduled time slot.
14
- 1 2. The method of claim 1, wherein the optical switched network comprises a photonic
2 burst switched (PBS) network.
- 1 3. The method of claim 2, wherein the optical burst switched network comprises a
2 wavelength-division multiplexed (WDM) PBS network.

3 4. The method of claim 1, wherein the lightpath route is dynamically discovered by
4 performing operations including:

5 maintaining a routing tree table at the source edge node containing a list of potential
6 lightpath routes that may be used to reach the destination edge node;

7 maintaining link availability information at the source edge node corresponding to an
8 availability of link and node resources in the optical switched network;

9 selecting a lightpath route from the routing tree table for which a lightpath reservation
10 during a scheduled time slot is to be made; and

11 verifying sufficient resources are available to support the lightpath reservation based
12 on the link availability information.

1

1 5. The method of claim 4, further comprising confirming each node has sufficient
2 resources to support data transmission via the lightpath route during the scheduled time slot.

1 6. The method of claim 5, further comprising:

2 sending an reservation error message to the source edge node if it is determined that a
3 node does not have sufficient resources to support data transmission via the lightpath route
4 during the scheduled time slot; and

5 selecting, at the source edge node, a new lightpath route to reserve resources for
6 based on the routing tree table and the resource availability information.

1 7. The method of claim 4, further comprising:

2 sending link state information indicative of an availability of node and link resources
3 for the optical switched network to the source edge node; and
4 updating the link availability information at the source edge node.

1 8. The method of claim 7, wherein the link state information is sent periodically from
2 the switching nodes in the optical switched network.

1 9. The method of claim 8, wherein link state information is sent from a switching node
2 in response to a resource reservation that has been confirmed for the switching node.

1 10. The method of claim 5, further comprising prioritizing the potential lightpaths in the
2 list based on at least one transmission-related criteria.

1 11. The method of claim 10, further comprising dynamically reprioritizing the potential
2 lightpaths in the list in response to a detected change in network transmission conditions.

1 12. The method of claim 10, wherein the potential lightpaths are prioritized based on
2 traffic balancing considerations.

1 13. The method of claim 10, further comprising dynamically reprioritizing the potential
2 lightpaths in the list in response to a detected change in network topology.

1

1 14. The method of claim 5, wherein verifying sufficient resources are available to support
2 the lightpath reservation based on the link availability information comprises:

3 identifying the switching nodes along the lightpath route; and
4 for each switching node:

5 aggregating any existing reservations for the node resource corresponding to a
6 specified bandwidth and the scheduled time slot to obtain an existing resource
7 allocation;

8 adding the bandwidth percentage corresponding to a resource reservation
9 request to the existing resource allocation to obtain a requested allocation for the node
10 resource; and

11 determining if the requested allocation exceeds a threshold.

1 15. The method of claim 4, further comprising:

2 making a soft reservation for a node resource if sufficient resources to support the
3 lightpath reservation are determined to be available for the time slot.

1 16. The method of claim 15, wherein soft reservations of the node resources are made
2 during a upstream traversal of the lightpath route, and the method further comprises:

3 passing a resource reservation response message between the nodes in a downstream
4 traversal of the lightpath route, the resource reservation response message including resource
5 reservation response information;

6 extracting, at each node, the resource reservation response information from the
7 resource reservation response message; and

8 changing, at each node, the soft reservation for the node resource to a hard
9 reservation.

1 17. The method of claim 16, wherein the resource reservation response message
2 comprises a *Resv* message having a format based on an extension to the RSVP-TE
3 (ReSerVation Protocol – Traffic Engineering) signaling protocol.

1 18. The method of claim 4, wherein the lightpath reservation message includes a
2 generalized multi-protocol label-switching (GMPLS)-based label defining transmission
3 parameters for a lightpath segment to which the GMPLS-based label corresponds.

1 19. The method of claim 18, wherein the GMPLS-based label includes at least one field
2 identifying an input wavelength employed for carrying signals over a lightpath segment
3 identified by the GMPLS-based label.

1 20. The method of claim 4, wherein the lightpath reservation message comprises a *Path*
2 message having a format based on an extension to the RSVP-TE (ReSerVation Protocol –
3 Traffic Engineering) signaling protocol.

1 21. The method of claim 1, wherein a partial use of a network resource may be reserved.

1 22. The method of claim 21, wherein the partial use comprises a bandwidth percentage
2 use of a lightpath segment.

1 23. The method of claim 1, wherein the lightpath route is dynamically discovered using a
2 modified version of the Open Shortest Path First (OSPF) protocol based on updated link state
3 information.

1 24. An edge node apparatus for use in an optical switched network, comprising:
2 a processor;
3 an optical switched network interface, coupled to the processor; including at least one
4 optical port;
5 an external network interface, coupled to the processor, including at least one external
6 network port;
7 memory, coupled to the processor; and
8 storage, coupled to the processor, in which instructions are stored, which when
9 executed by the processor perform operations, including:

10 maintaining a routing tree table in memory identifying applicable routes to
11 route data between the edge node apparatus when implemented as a source node in an
12 optical switched network and other nodes in the optical switched network;

13 maintaining link availability information in the memory corresponding to a
14 future availability of link and node resources in the optical switched network;

15 selecting a lightpath route from the routing tree table for which a lightpath
16 reservation during a scheduled time slot is to be made, said lightpath route spanning
17 from the edge node apparatus to a destination node and including at least one
18 switching node in the optical switched network;

19 verifying sufficient resources are available to support the lightpath reservation
20 based on the link availability information;
21 generating a lightpath reservation message explicitly identifying the selected
22 route; and
23 forwarding the lightpath reservation message to a first hop node along the
24 selected route.

1 25. The edge node apparatus of claim 24, wherein execution of the instructions further
2 performs the operation of reserving a resource corresponding to transmission of data over a
3 first lightpath segment coupled between the optical switched network interface and a first
4 hop node along the lightpath route.

1 26. The edge node apparatus of claim 24, wherein the resource is reserved by performing
2 operations including:
3 making a soft reservation of resources supporting data transmission via the
4 first lightpath segment for the scheduled time slot;
5 receiving a reservation response; and
6 changing the soft reservation to a hard reservation to commit the resources for
7 the scheduled time slot.

1 27. The edge node apparatus of claim 24, wherein execution of the instructions further
2 performs the operation of:

3 receiving link state information indicative of an availability of node and link
4 resources for the optical switched network; and
5 updating the link availability information.

1 28. The edge node apparatus of claim 24, wherein the optical switched network
2 comprises a photonic burst switched (PBS) network.

1 29. The edge node apparatus of claim 24, wherein the optical switched network
2 comprises a wavelength-division multiplexed (WDM) PBS network; and the optical switched
3 network interface includes at least one optical port supporting concurrent transmission of
4 respective optical signals comprising different wavelengths.

1 30. The edge node apparatus of claim 24, wherein the lightpath resource reservation
2 request message comprises a *Path* message having a format based on an extension to the
3 RSVP-TE (ReSerVation Protocol – Traffic Engineering) signaling protocol and includes
4 routing information defining an explicit route corresponding to the selected lightpath route
5 via which the *Path* message is to be forwarded.

1 31. The edge node apparatus of claim 24, wherein execution of the instructions further
2 performs the operation of prioritizing the applicable routes in the routing tree table based on
3 at least one transmission-related criteria.

1 32. The edge node apparatus of claim 31, wherein execution of the instructions further
2 performs the operation of dynamically reprioritizing the applicable routes in the routing tree
3 table in response to a detected change in network transmission conditions.

1 33. The edge node apparatus of claim 31, wherein the applicable lightpaths are prioritized
2 based on traffic balancing considerations.

1 34. The edge node apparatus of claim 31, wherein execution of the instructions further
2 performs the operation of dynamically reprioritizing the applicable routes in the routing tree
3 table in response to a detected change in network topology.

1 35. The switching node apparatus of claim 24, wherein verifying sufficient resources are
2 available to support the lightpath reservation based on the link availability information
3 comprises:

4 identifying the switching nodes along the lightpath route;

5 for each switching node:

6 aggregating any existing reservations for the node resource corresponding to a
7 specified bandwidth and the scheduled time slot to obtain an existing resource
8 allocation;

9 adding the bandwidth percentage corresponding to a resource reservation
10 request to the existing resource allocation to obtain a requested allocation for the node
11 resource; and

12 determining if the requested allocation exceeds a threshold.

1 36. A machine-readable medium to provide instructions, which when executed by a
2 processor in a edge node apparatus comprising a source node in an optical switched network,
3 cause the edge node apparatus to perform operations comprising:

4 maintaining a routing tree table identifying applicable routes to route data
5 between the edge node apparatus other nodes in the optical switched network;

6 maintaining link availability information corresponding to a future availability
7 of link and node resources in the optical switched network;

8 selecting a lightpath route from the routing tree table for which a lightpath
9 reservation during a scheduled time slot is to be made, said lightpath route spanning
10 from the edge node apparatus to a destination node and including at least one
11 switching node in the optical switched network;

12 verifying sufficient resources are available to support the lightpath reservation
13 based on the link availability information;

14 generating a lightpath reservation message explicitly identifying the selected
15 route; and

16 forwarding the lightpath reservation message to a first hop node along the
17 selected route.

1 37. The machine-readable medium of claim 36, wherein execution of the instructions
2 further performs the operations of:

3 receiving link state information indicative of an availability of node and link
4 resources for the optical switched network; and

5 updating the link availability information.

1 38. The machine-readable medium of claim 36, wherein execution of the instructions
2 further performs the operation of prioritizing the applicable routes in the routing tree table
3 based on at least one transmission-related criteria.